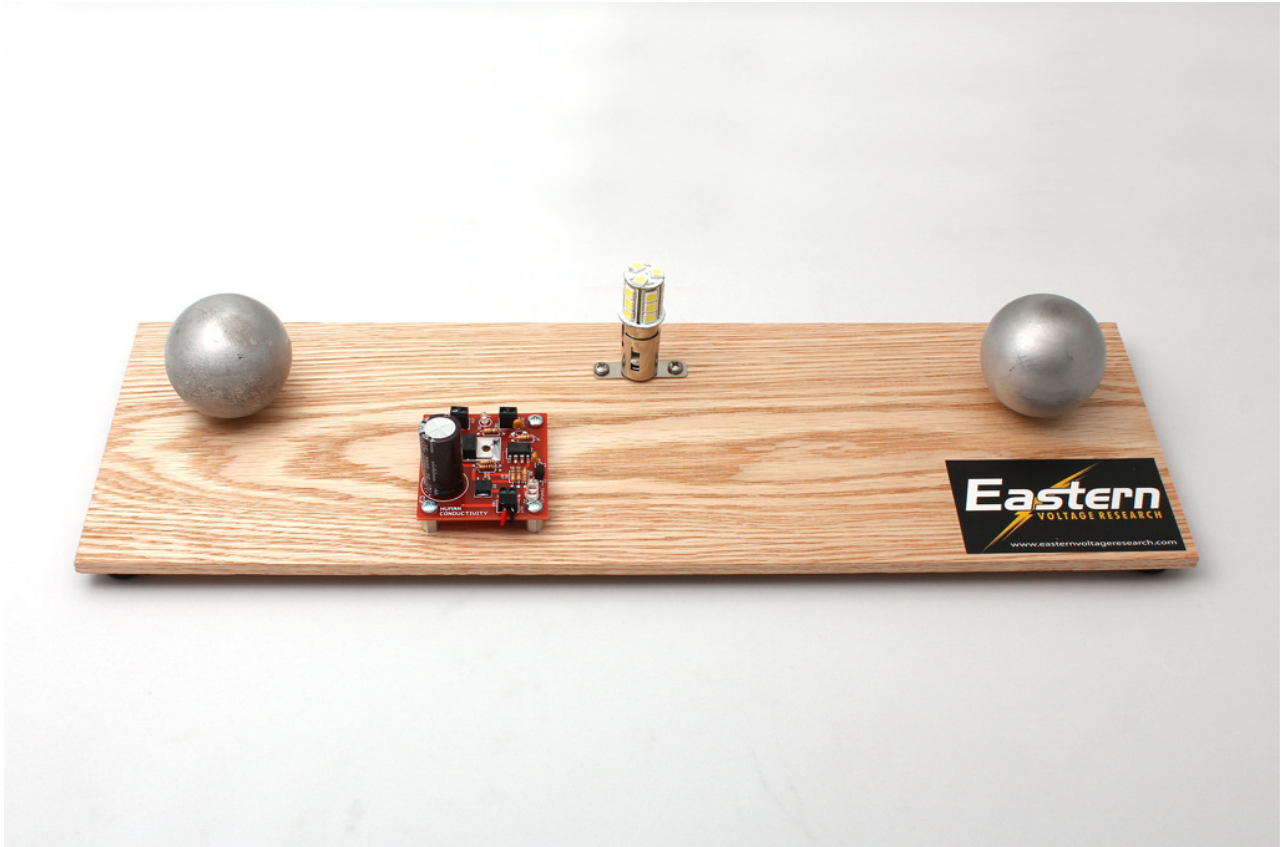
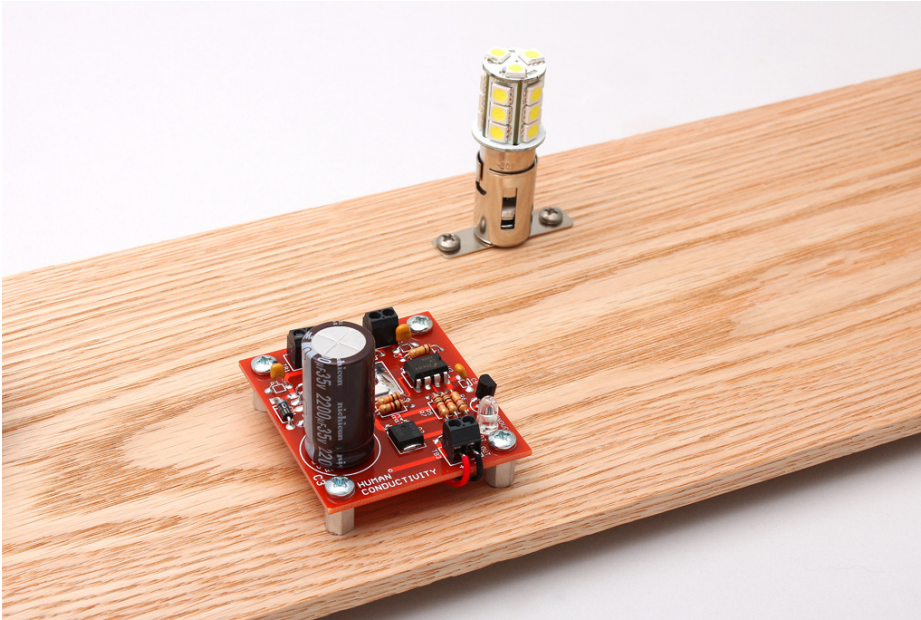


# ***Body Light 1.0 Kit***



# ***Instruction Manual***

**Eastern Voltage Research, LLC**



## **Introduction to the Body Light 1.0 Kit**

Thank you for purchasing the Body Light 1.0 Kit. This kit has become one of our most popular educational kits. So how did it come about? Well, a student in one of our scouting groups recently asked if the human body conducts electricity, to which I replied, "yes, it does." She then asked if I could show her how it does this. Well, not wanting to stick my hand in the nearby 115VAC outlet and show her firsthand how electricity conducts itself through the human body, I simply promised her that the next week the scouting group would meet, I would have something to demonstrate this. So I thought about this for a little bit and came up with a very simple circuit to demonstrate this property of human conduction. The circuit I simply named, "The Body Light."

Next week when demonstrated, the kit proved to be quite successful. The students just loved the Body Light, as it was now called, and couldn't get enough of it. They connected themselves into large chains of individuals and could activate the circuit with 5 and more bodies connected hand in hand. Even the scouting instructors loved the kit and I was so surprised at how entertaining it was despite the fact it was electrically so simple.

**Notice to Beginners:** If you are a first time kit builder, you may find this instruction manual easier to understand than expected. Each component in this kit has an individual check box, while a detailed description of each component is provided as well. If you follow each step in the instruction manual in order, and practice good soldering and kit building skills, the kit is next to fail-safe.



**Please read this manual in its entirety before building, testing, or operating your kit!**

## **Circuit Description**

The principal of operation is quite simple. The circuit is simply a basic comparator. When the input voltage to the comparator exceeds a preset threshold, the comparator will trigger and illuminate both an onboard and external light source.

One of the stationary electrodes is connected to the 12VDC, and the other stationary electrode is connected to the input of the LM386 amplifier which acts as a comparator. Resistive divider R3 / R4 creates a reference voltage of approximately 1V which is present on the input of the LM358. When a person puts their hands across the two stationary electrodes, the 12V is conducted through that person which charges up the 1uF capacitor, C4. When C4 is charged up greater than 1V, it will trigger the LM358 to a “high” output state which will drive and turn ON transistors Q1 (2N2222) and Q2 (MJD122T4). Transistor Q1 (2N2222) illuminates an onboard white LED while transistor Q2 (MJD122T4) is a high power darlington transistor which can drive high power lighting sources such as halogen and incandescent bulbs, as well as high power LEDs. For our demonstration model, we utilized a BA15S automotive LED which is pictured in the image above.

The 100k resistor, R2 on the input to the LM358 provides a path for capacitor, C4, to bleed down when the circuit is disconnected at the electrodes, while 1uF capacitor, C4, is there to provide noise immunity for the comparator. If C4 was not present, you would get false trips. C4 also provides a brief delay between the time the electrode circuit is closed and the onboard and external lights illuminate.

There is also an onboard 12V voltage regulator (LM7812), U1. This converts the input voltage to 12V. Please note, that if a voltage source less than 14V is utilized, the output voltage of the LM7812 will merely equal the voltage at the input. This voltage regulator just ensures that the voltage present on the electrodes never exceeds 12V.

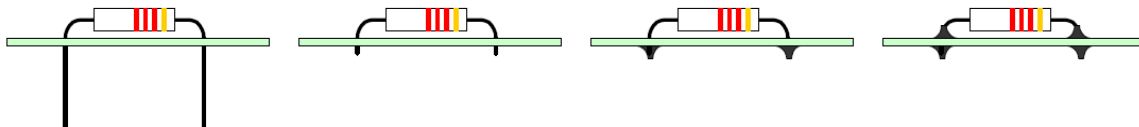
## **Kit Building Tips**

A good soldering technique is key! Let your soldering iron tip gently heat both the wires and pads simultaneously. Apply solder to the wire and the pad when the pad is hot

enough to melt the solder. The finished joint should appear like a small shiny drop of water on paper, somewhat soaked in. If the pads have not heated up sufficiently, melted solder (heated only by the soldering iron itself) will form a cold solder joint and will not conduct properly. These cold joints appear as dull beads of solder, and can be easily fixed by applying additional heat to the pad and wire. All components, unless otherwise noted, should be mounted on the top side of the board. This is the side with the silkscreen printing.

When installing components, the component is placed flat to the board and the leads are bent on the backside of the board to prevent the part from falling out before soldering. The part is then soldered securely to the board, and the remaining lead length is clipped off. It is also extremely important to place the components as close to the board as possible. This is necessary for proper operation over the wide frequency range of the various kits we provide. Also be sure that component lead lengths are always as short as possible. This will avoid adding any stray capacitances or inductances that can be detrimental to circuit operation.

An alternative approach (which is actually the one I use) is to install the component into the board and then apply a piece of masking tape on the topside to hold the component in place temporarily. The leads on the backside of the board are then trimmed leaving about 0.10" lead protruding through the backside of the board, and then soldered from the backside. You can then remove the masking tape, and finally apply a small amount of solder on the top to complete the joint on both sides. This is shown in the figure below.

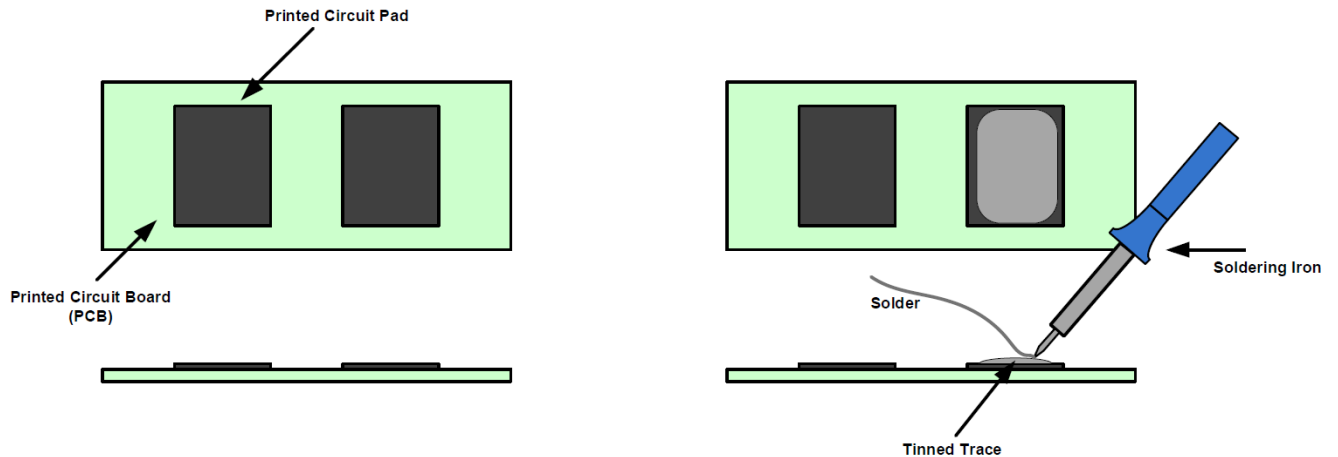


## Surface Mount (SMT) Component Soldering Instructions

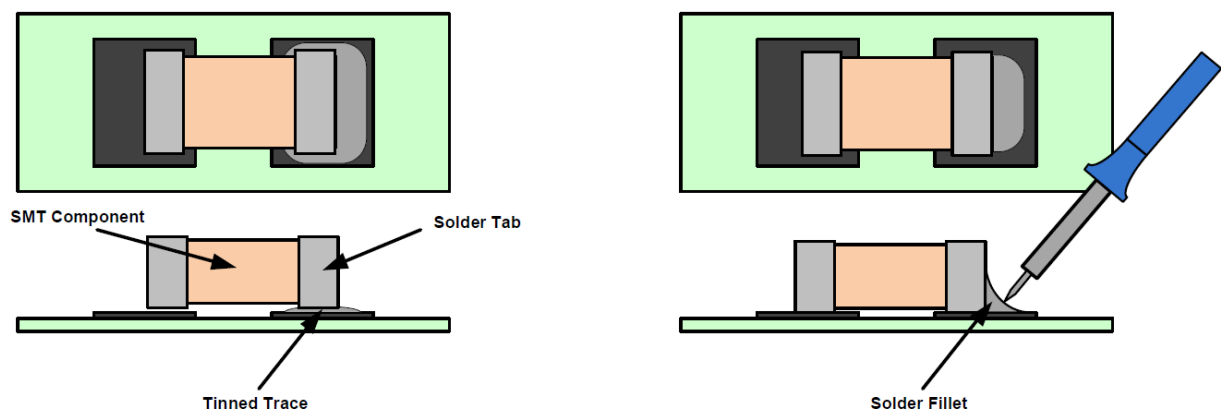
One of the first things you'll notice with your electronics kit is that many of the included components are surface mount components. These components do not have conventional leads, as is the case with thru-hole components, and instead solder directly to pads located either on the top or bottom of the PCB board.

One of the first things to remember when soldering surface mount (SMT) components to the board is that patience is a must! The first step when soldering a SMT component to the board, after properly identifying both the component and the location where it will be

installed on the PCB board, is to slightly “tin” one of the pads on the PCB board that will connect to the component. This is accomplished by simply applying a very small amount of solder directly to the pad with the soldering iron as shown below.



The next step is to pick up and hold the component in place on its tinned pad using tweezers. While holding the component in place with tweezers, briefly re-heat the solder with the soldering iron so that it flows onto the component solder tab and forms a nicely shaped solder fillet. For the remaining solder tabs on the same component, briefly heat up the component tab using the soldering iron and apply a small amount of solder directly to the pad, again creating a nicely shaped solder fillet. It is important to note that when reheating the solder, the soldering iron tip should contact the solder tab of the body of the component and not the solder directly. This will allow the solder to flow as efficiently as possible and form a proper solder fillet.



At first, surface mount soldering may seem a bit difficult, but it's actually much easier than thru-hole soldering once you get the hang of it. Good luck and take your time!

## Body Light 1.0 Kit Parts List

### RESISTORS

- 1 2k Resistor (red-black-red), R1
- 1 100k Resistor (brown-black-yellow), R2
- 1 10k Resistor (brown-black-orange), R3
- 3 1k Resistor (brown-black-red),R4,R6,R7
- 1 20k Resistor (red-black-orange),R5

### CAPACITORS

- 3 0.1uF Capacitor, Ceramic, C1,C2,C5
- 1 1uF Capacitor, Ceramic, C4
- 1 1000uF Capacitor, Electrolytic, C3 (or similar value)

### DIODES

- 1 Diode, 1N4002, CR1
- 1 Diode, 1N4148, CR2
- 1 LED, T-1, Blue, D1
- 1 LED, T-1 3/4, White, D2

### SEMICONDUCTORS

- 1 2N2222, Transistor, Q1
- 1 MJD122T4, Transistor, SMT, Q2
- 1 LM7812 Voltage Regulator, U1
- 1 LM358 Amplifier, U2

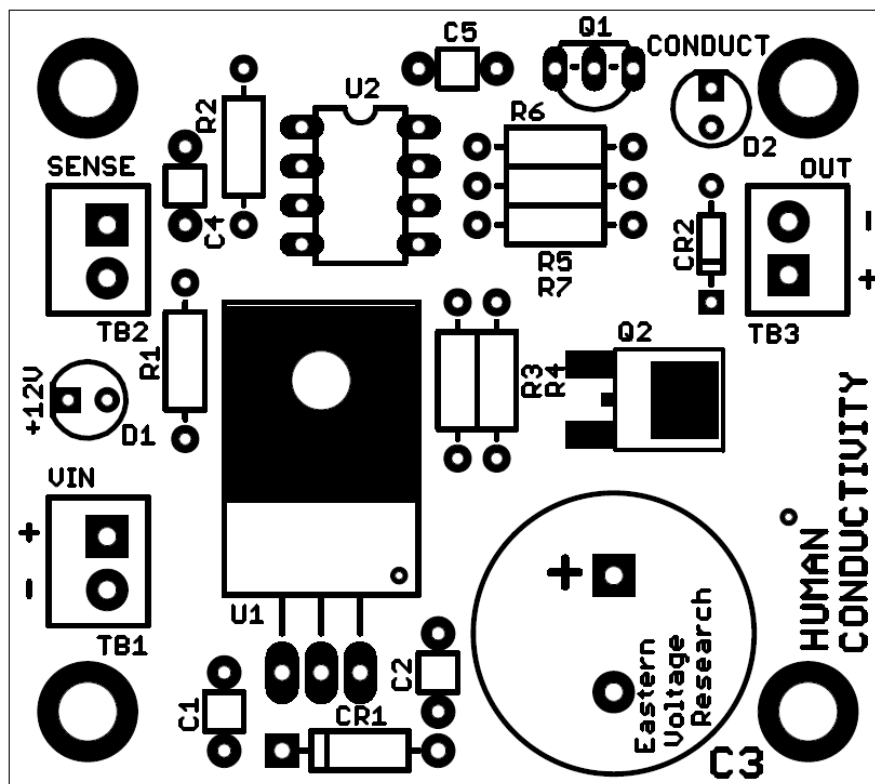
**MISCELLANEOUS**

- 3 Terminal Block, 2-Position
- 1 Power Supply, 12V (Deluxe Kit only)
- 1 PCB Board, Body Light 1.0
- 1 Schematic, Body Light 1.0

**REQUIRED, NOT SUPPLIED**

- 1 Power Supply (if you didn't purchase the deluxe kit)
- 1 External Light Source (LED, Halogen Bulb, etc...) (OPTIONAL)
- 1 External Light Source Socket (OPTIONAL)
- 2 Drawer Knobs, or similar, to be used as electrodes (Local hardware store)
- 1 Wood base
- A/R Misc. Hardware (nuts, screws, etc...)
- A/R Hook-up wire

**Body Light Kit 1.0 - Component Layout Diagram**



## **KIT Building Instructions**

Now we will begin building the kit. There are just a few more important things to know before we install the first components.

For each component, the word “install” always means the following:

1. Pick the correct value to start with.
2. Insert the component into the correct printed circuit board (PCB) location.
3. Orient the component correctly – especially when there is a right and a wrong way to solder it in. (i.e. Electrolytic capacitors, diodes, ICs, transistors, etc...)
4. Solder all connections unless directed otherwise. Ensure enough heat is used to allow solder to flow for clean, shiny, and completed connections.

Also, please be sure to take us seriously when we say that good soldering is the key to the proper operation of your circuit!

- Use a 25W soldering pencil with a clean, sharp tip. **DO NOT USE** a high power soldering gun such as those trigger activated units.
- Use only rosin core solder intended for electronics use
- Ensure your work area is clean, and has plenty of bright lighting
- Build your kit in stages, taking breaks to check your work. Be sure to clean the board periodically with a brush or compressed air to remove any excess wire cuttings, etc...

Okay, so lets begin!

1. Install R1, 2k resistor (red-black-red)
2. Install R2, 100k resistor (brown-black-yellow)
3. Install R3, 10k resistor (brown-black-orange)
4. Install R4, 1k resistor (brown-black-red)
5. Install R5, 20k resistor (red-black-orange)
6. Install R6, 1k resistor (brown-black-red)
7. Install R7, 1k resistor (brown-black-red)

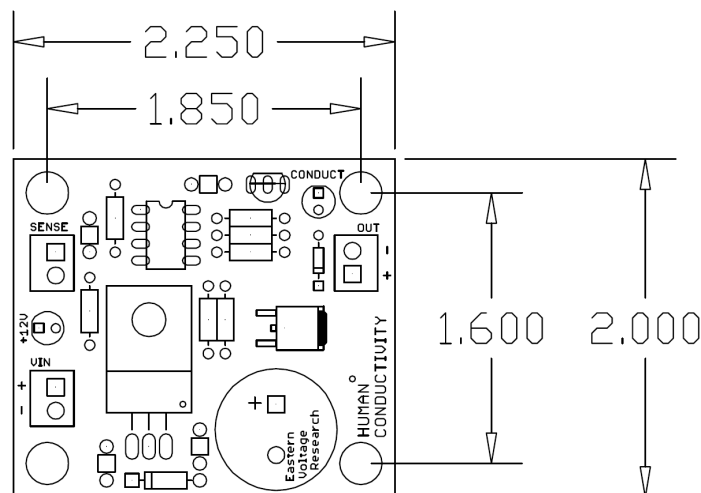


- 8. Install CR1, 1N4002 diode. The cathode band on the diode must match that shown on the silkscreen.
- 9. Install CR2, 1N4148 diode. The cathode band on the diode must match that shown on the silkscreen.
- 10. Install D1, Blue LED (smaller LED provided in the kit). The short lead of the diode is the cathode and will install into the square pad on the PCB board.
- 11. Install D2, White LED (larger LED provided in the kit). The short lead of the diode is the cathode and will install into the square pad on the PCB board.
- 12. Install C1, 0.1uF capacitor (marking BC104)
- 13. Install C2, 0.1uF capacitor (marking BC104)
- 14. Install C3, 0.1uF capacitor (marking BC104)
- 15. Install C4, 1uF capacitor (marking BC105)
  
- 16. Install Q2, MJD122T4 transistor. This is the surface mount transistor provided in the kit. Please solder to board using the techniques described above in these instructions. **IMPORTANT: The heatsink tab of this component is an electrical connection and must be soldered to the board.**
- 17. Install Q1, 2N2222 transistor. This transistor needs to be orientated properly. Please insert Q1 into the board with the flat edge of the transistor orientated according to the silkscreen layout drawing.
- 18. Install U2, LM358 Op-Amp. The LM358 may be soldered directly to the PCB without worry, but you may use an 8-pin DIP socket (not supplied) if you prefer. Use the same care in soldering such a socket and inserting the IC as you would in direct soldering of the chip. Note that one end of the IC is marked by a dot, notch, or band; this end **MUST** be oriented as shown on the PCB layout.
- 19. Install U1, LM7812 Linear Regulator. The tab should be soldered directly to the PCB board or use mounting hardware (not supplied) if desired.
- 20. Install C3, 1000uF, 16V (or similar) electrolytic capacitor. C3 has “polarity.” Polarity means the capacitor must be inserted a certain way. You may notice that one side of the capacitor, there is a black stripe with minus signs. This is the negative end. Looking at the PCB silkscreen, you will notice the positive side

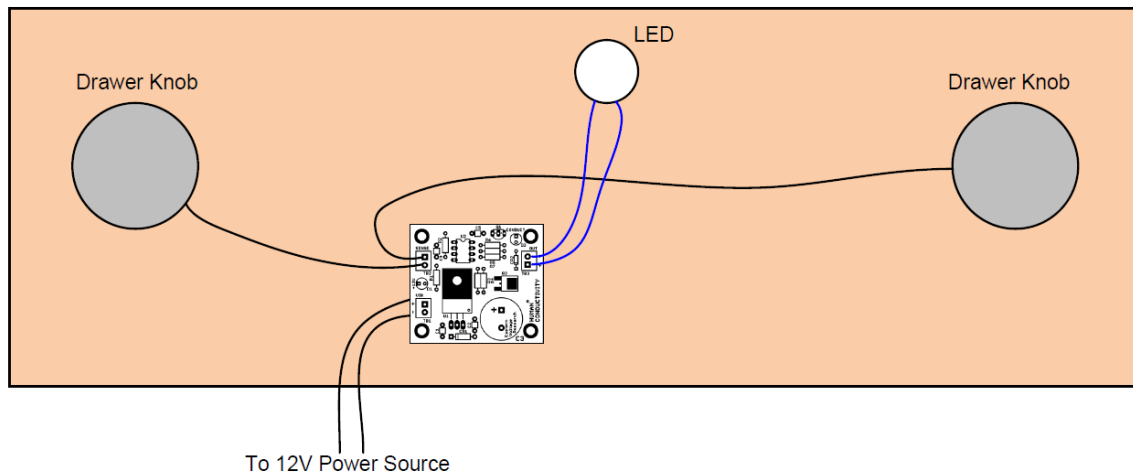
- marked. Install this capacitor into the board ensuring the positive side of the capacitor installs in the hole that is marked positive on the PCB layout.
- 21. Install the three (3) terminal blocks, TB1, TB2, and TB3.
  - 22. Connect 12V power transformer cord to the board as shown in the figure below. Use a multimeter to determine which lead is positive and install into the terminal block TB1 terminal marked “+.” Install the negative lead into the terminal block TB1 terminal marked “-.”
  - 23. Connect two wires to the TB2 sense terminals. These are the two handheld sensor wires. They can either be left as wires or connected to metal electrodes such as spherical drawer knobs.
  - 24. If using an external light, connect it as shown in the figure below to terminal TB3.



**If using an external LED, make sure it has internal current limiting. If it does not, you will need to add the proper current limiting resistor in series with it. We recommend using automotive type LEDs which can be purchased from various LED online suppliers such as [www.superbrightleds.com](http://www.superbrightleds.com). These LEDs have internal current limiting and come in a wide variety of bulbs, colors, etc...**



Mounting Dimensions (Mounting holes are sized for #6 screw)



Typical Application  
(Note: Wires would be routed underneath the board)

Congratulations! You have just completed your Body Light 1.0 kit. Please take a few moments to look over the board and ensure that all the components are installed properly with the correct orientation. Since some of the parts may be unfamiliar to you, you may want to be extra sure that they have been inserted correctly. After you are sure that everything seems to be properly installed, move on to the set-up and testing section.

## Set-up and Testing

Okay, so lets begin!

- 1. Plug-in the 12V power source.
- 2. Verify that the D1 +12V power LED indicator is illuminated. If not, check the voltage with a multimeter and verify that the LED is installed with the proper polarity.
- 3. Now simply hold each of the two sensor wires in your hands or touch the two electrodes. The white LED (or external lamp if used) should illuminate.

Congratulations! Your Body Light 1.0 is now completed and operational.

## **Troubleshooting**

**PROBLEM:** The LEDs do not illuminate when I turn the switch ON.

**SOLUTION:** Verify that the LEDs are installed correctly, the battery is installed correctly, and that the battery is not completely drained.

**PROBLEM:** The white (or external) LED does not illuminate when I touch the two electrodes.

**SOLUTION:** Ensure you have good electrical connection between the wires / electrodes and the terminal block. Ensure that the onboard LED, D2 and/or the external LED are installed with the proper polarity.

## **Conclusion**

We sincerely hope that you have enjoyed the construction of this Eastern Voltage Research Kit. As always, we have tried to write this instruction manual in the easiest, most “user friendly” format that is possible. As our customers, we value your opinions, comments, and additions that you would like to see in future publications. Please submit comments or ideas to:

Eastern Voltage Research, LLC

Technical Support  
support@easternvoltage.com

Thanks again from the people here at Eastern Voltage Research.

## **Terms and Conditions of Sale**

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<http://www.easternvoltage.com/terms.html>